



LCCM: More than Competent

Presented at:

6th International Cannon Artillery Firepower Symposium

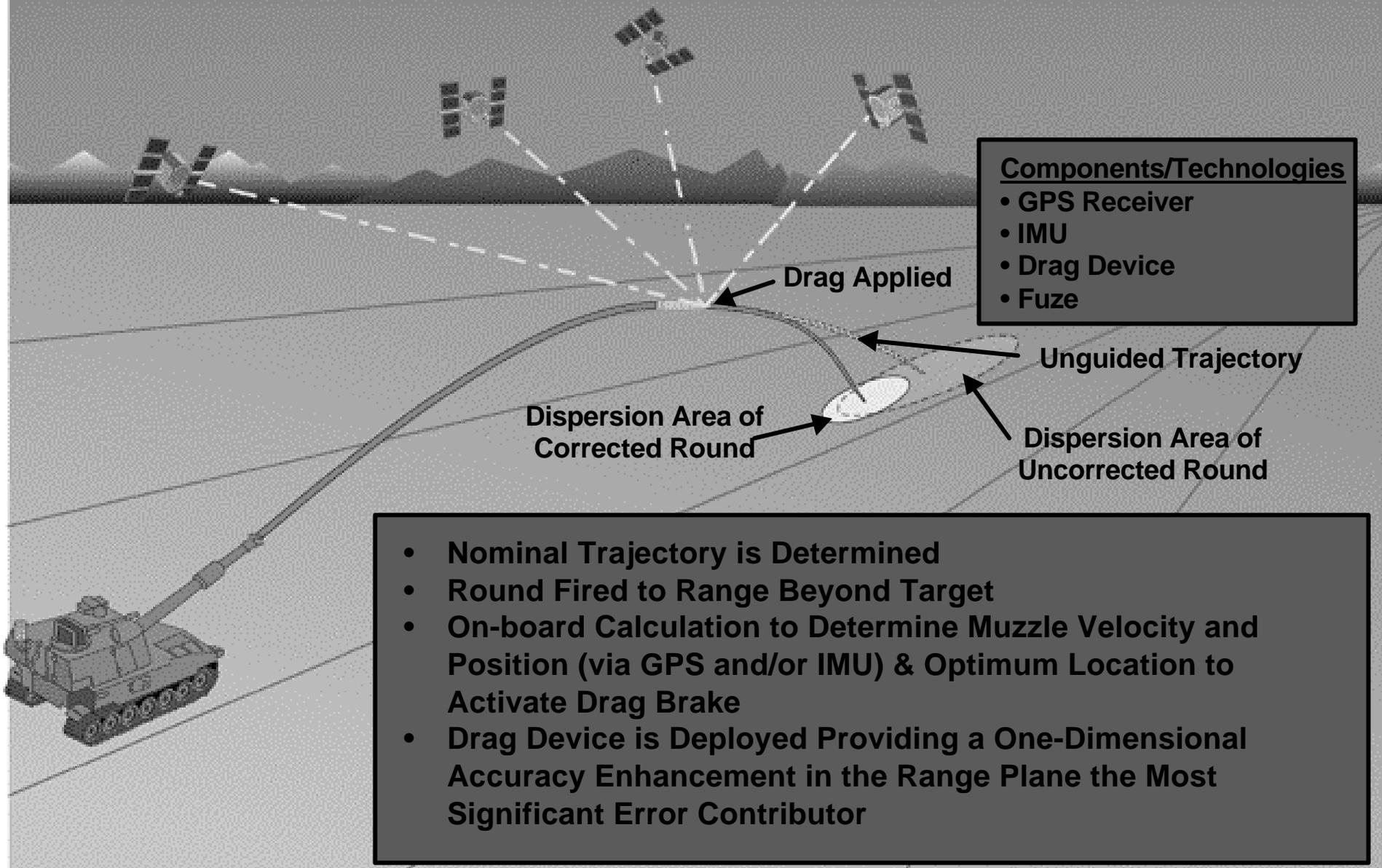
21 June 2000

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What is LCCM?

LCCM is a low-cost, fuze-sized module which is used in lieu of a standard fuze on existing stockpile munitions to significantly enhance their effectiveness by reducing ballistic delivery errors

1-D (Range Correction) LCCM



Components/Technologies

- GPS Receiver
- IMU
- Drag Device
- Fuze

Drag Applied

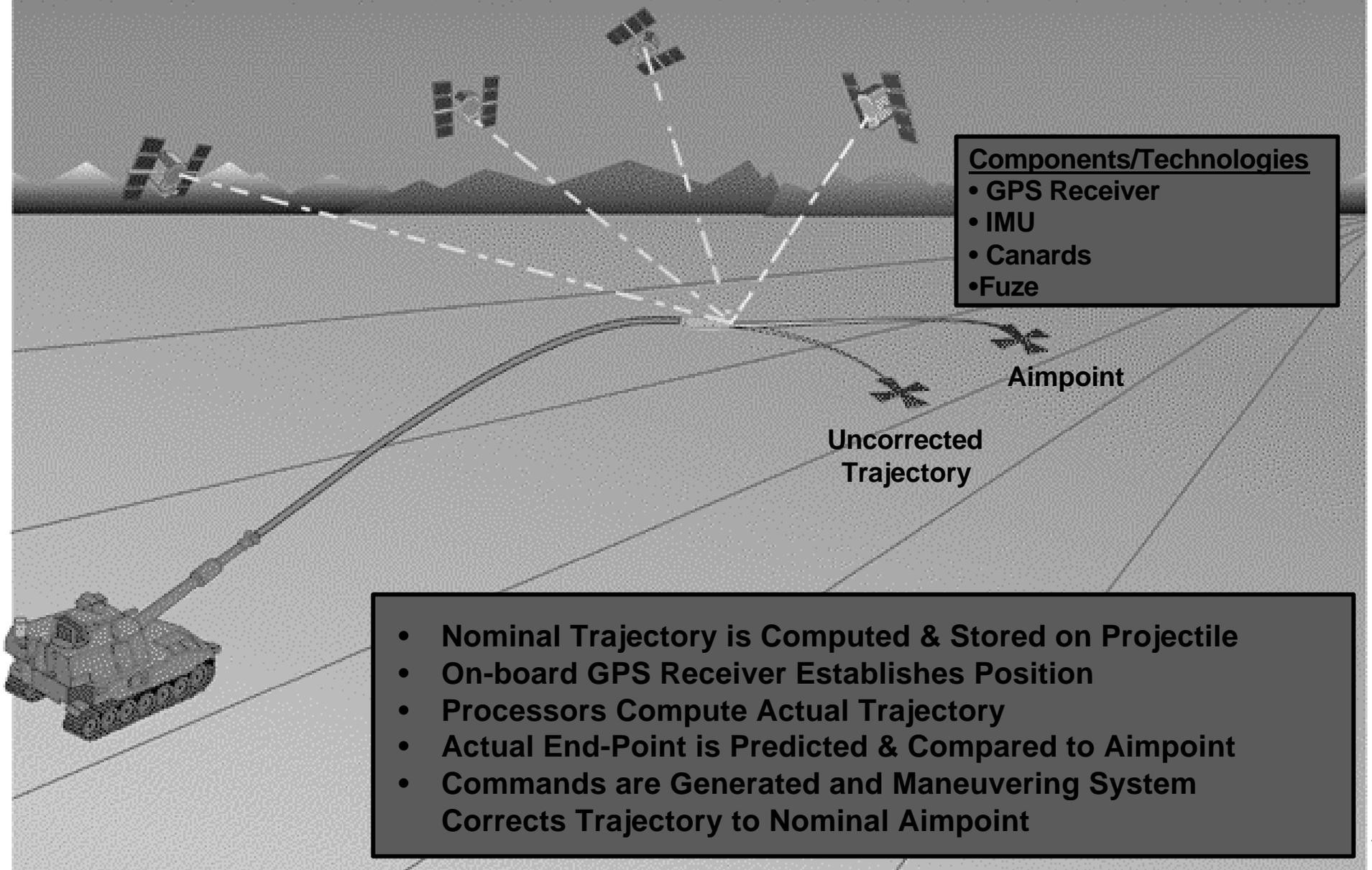
Unguided Trajectory

Dispersion Area of Corrected Round

Dispersion Area of Uncorrected Round

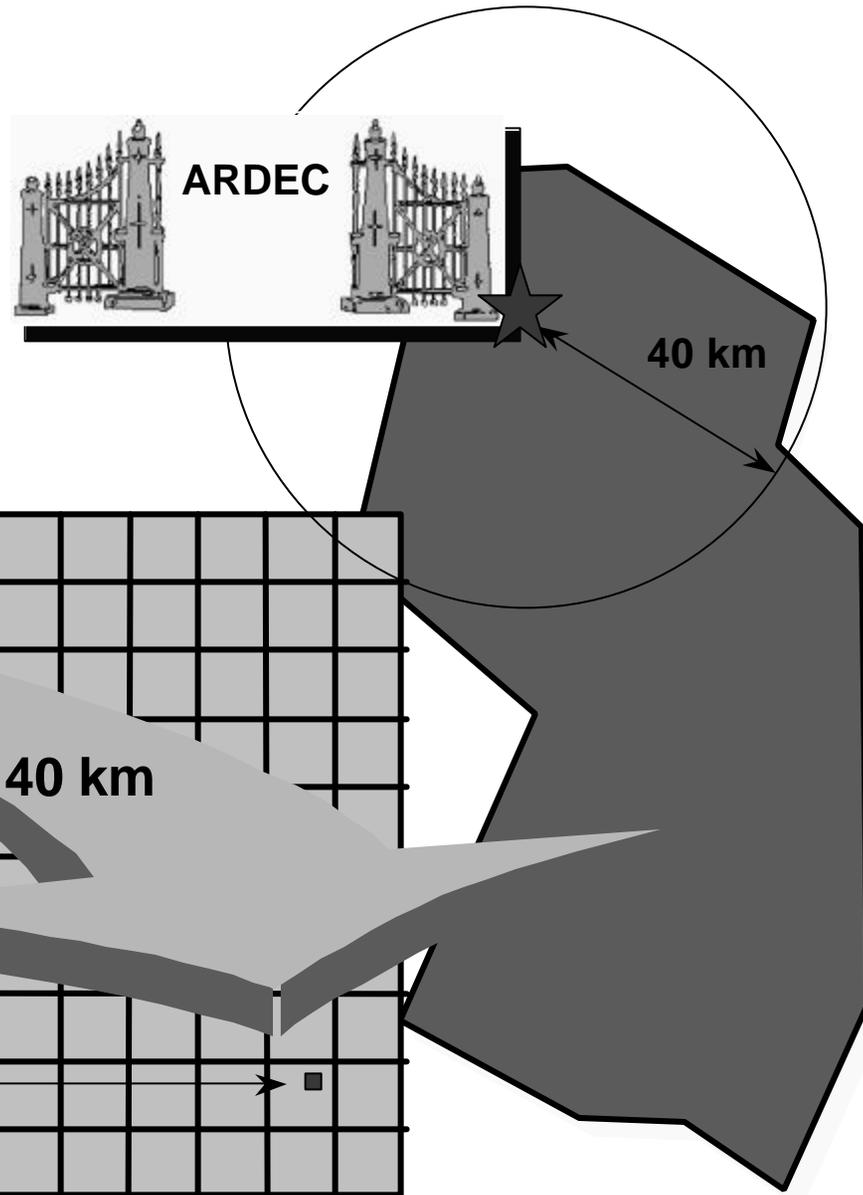
- Nominal Trajectory is Determined
- Round Fired to Range Beyond Target
- On-board Calculation to Determine Muzzle Velocity and Position (via GPS and/or IMU) & Optimum Location to Activate Drag Brake
- Drag Device is Deployed Providing a One-Dimensional Accuracy Enhancement in the Range Plane the Most Significant Error Contributor

2-D Guided LCCM

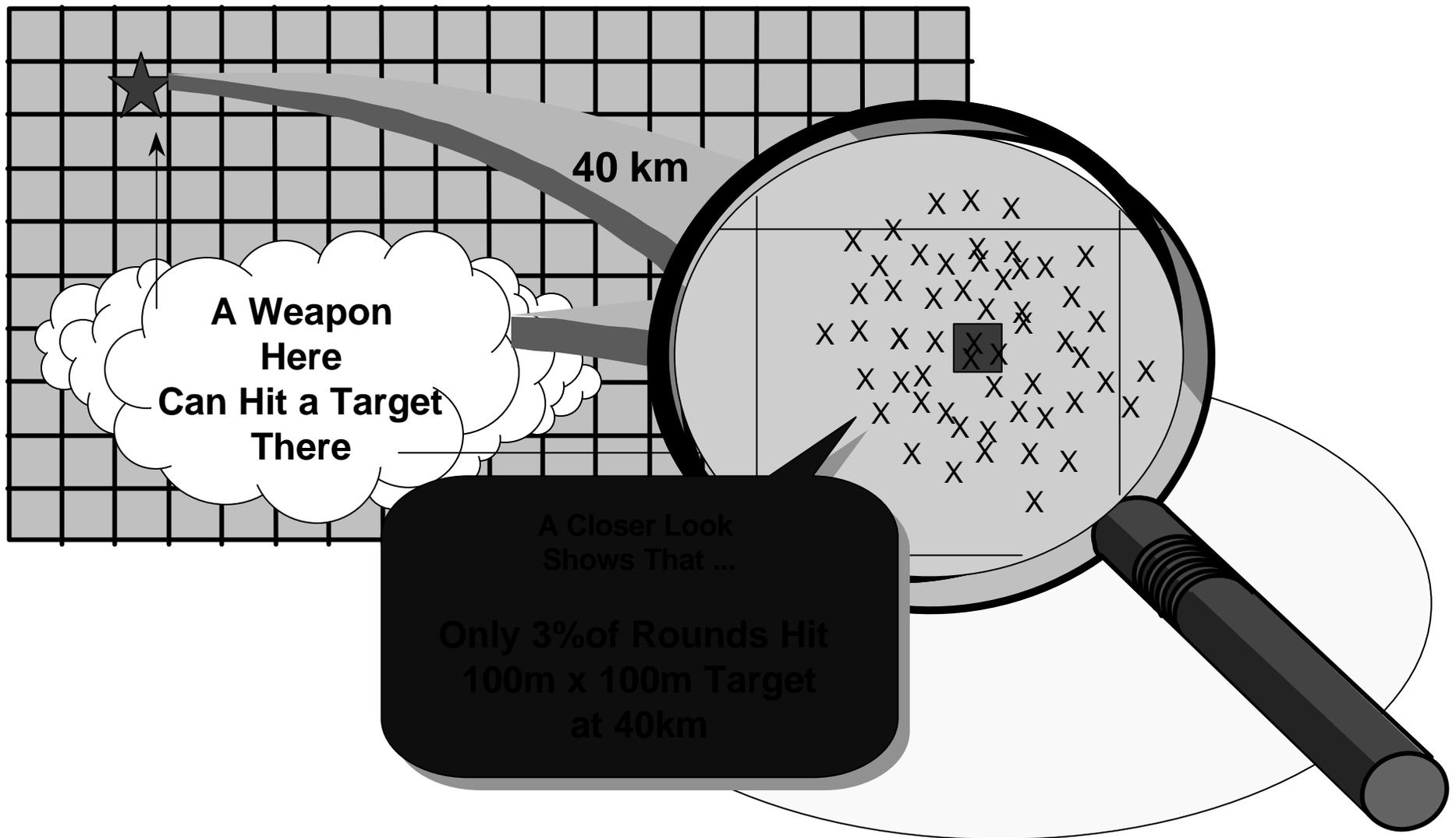


Artillery is King of Battle

**Cannon Artillery Provides
Wide Battlefield Coverage
(approx. 2500 Sq. Km)**

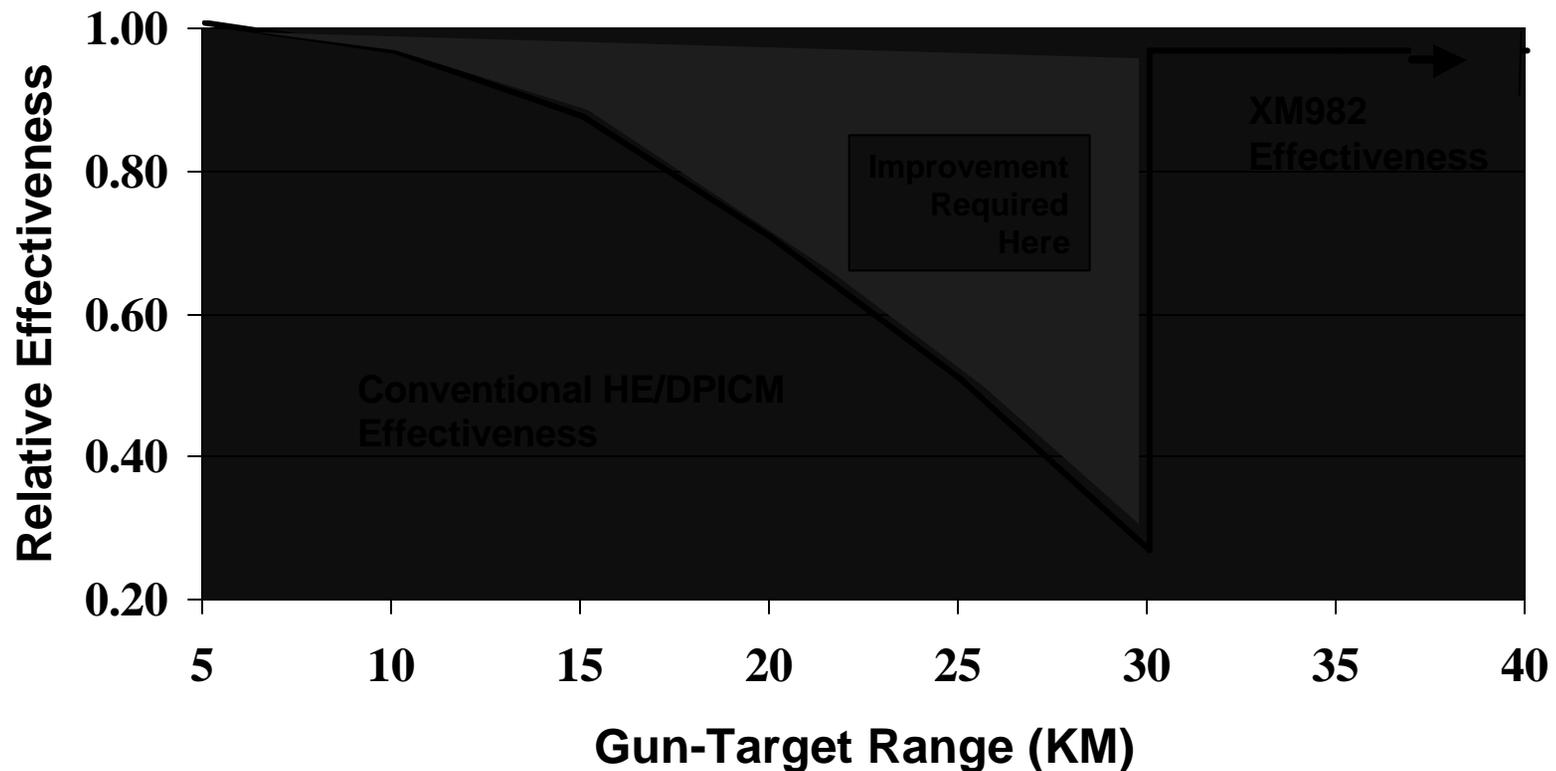


But It Could Be (a Lot) Better



Why LCCM? (1)

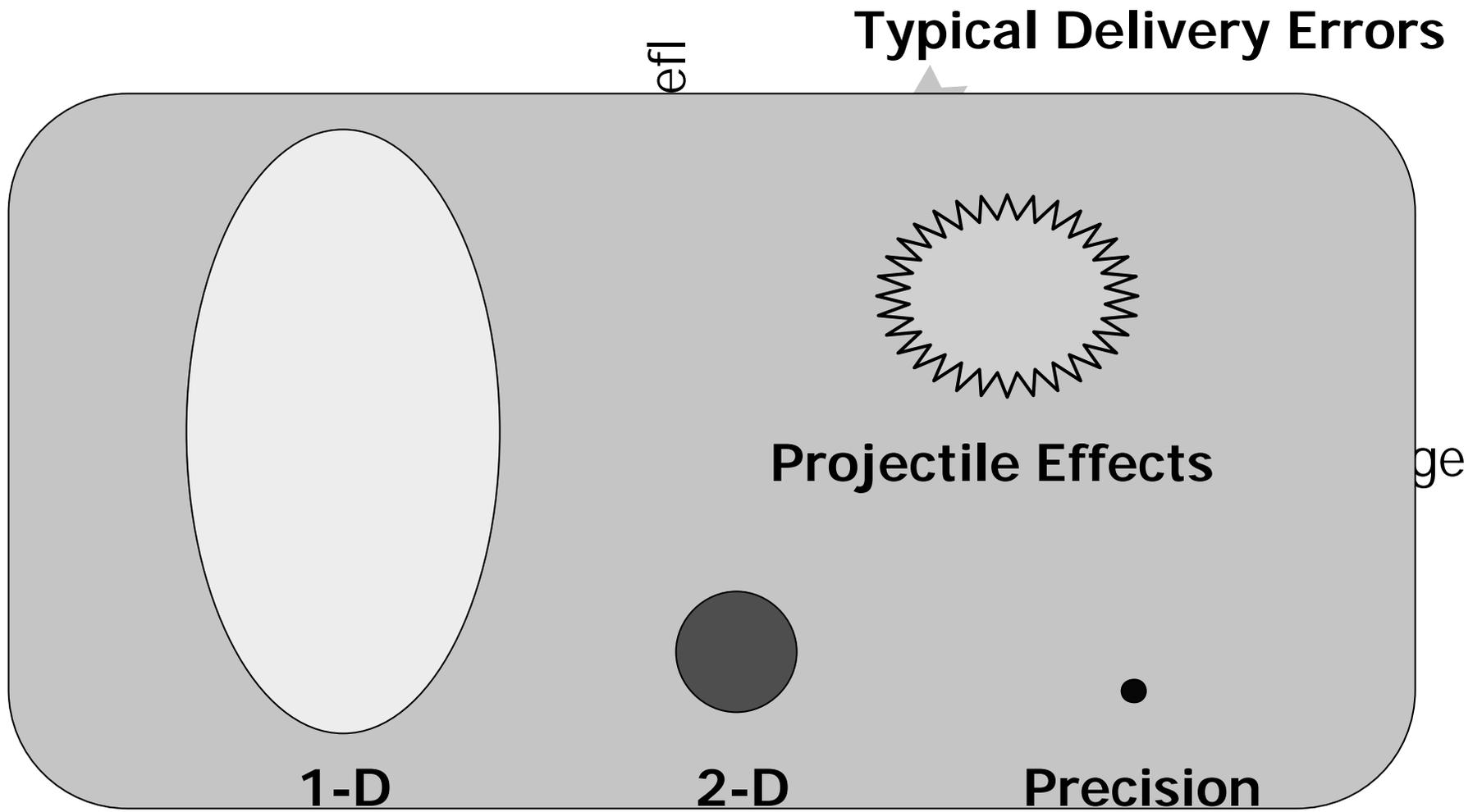
Conventional Munitions are Less Effective at Longer Ranges



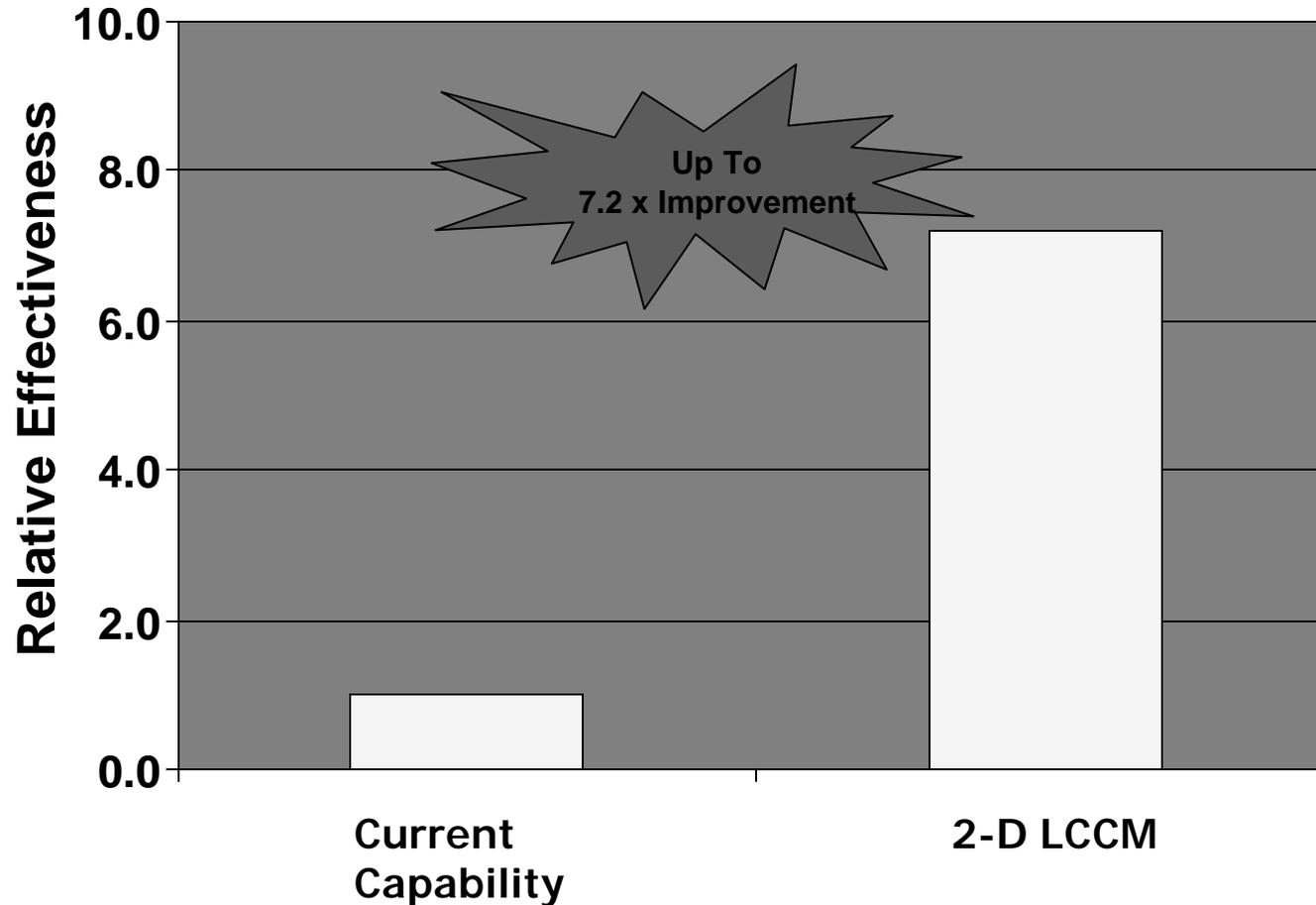
Why LCCM? (2)

- Artillery is NOT (by choice) an area weapon!
- Most Artillery Rounds Wasted – No lethal Effect
- Opportunity for Efficiency Improvement is Enormous
- Synergistic with Smart Munitions and Improvements in Target Acquisition Devices
- G & C is Parasitic Weight/Volume

Artillery Delivery Errors & Projectile Lethality

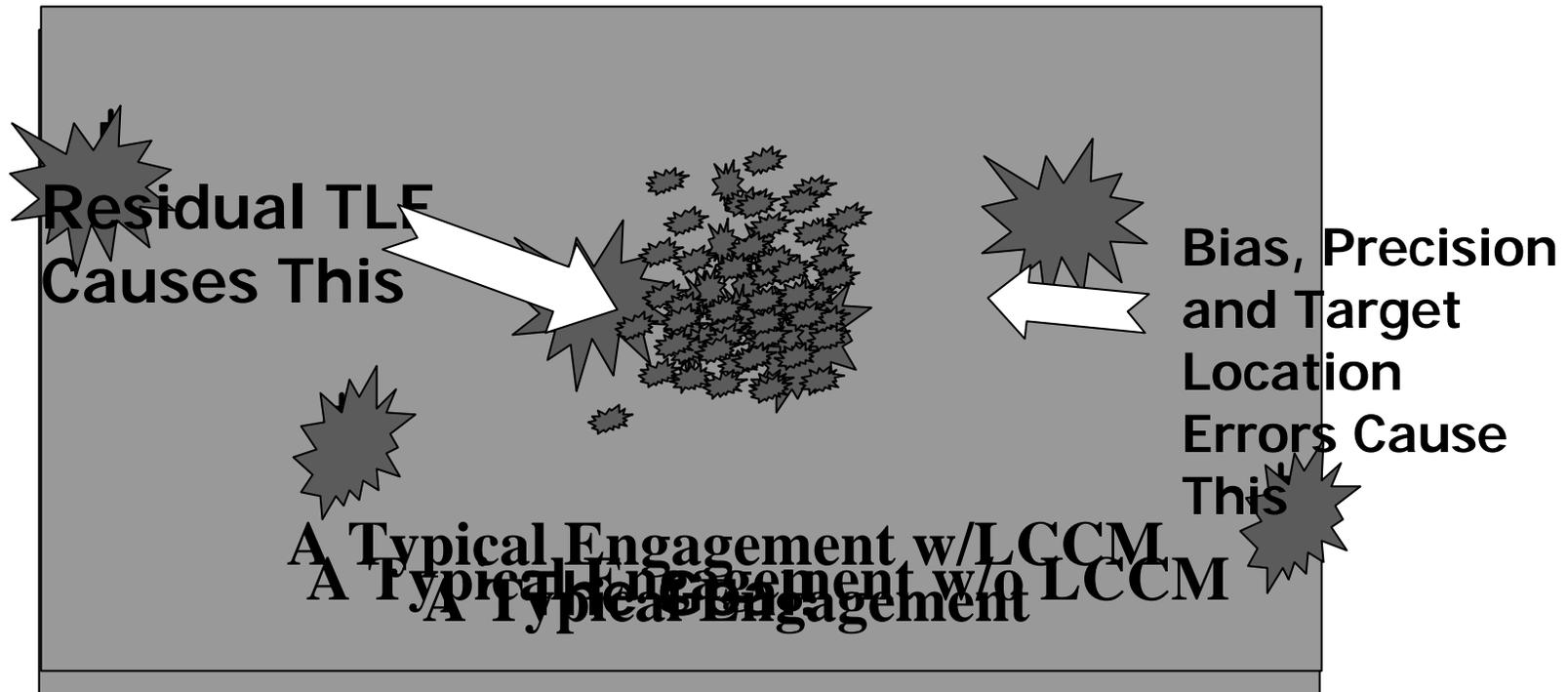


LCCM Improves Projectile Effectiveness (DPICM Projectile vs Area Target at 30KM w/current TLE)

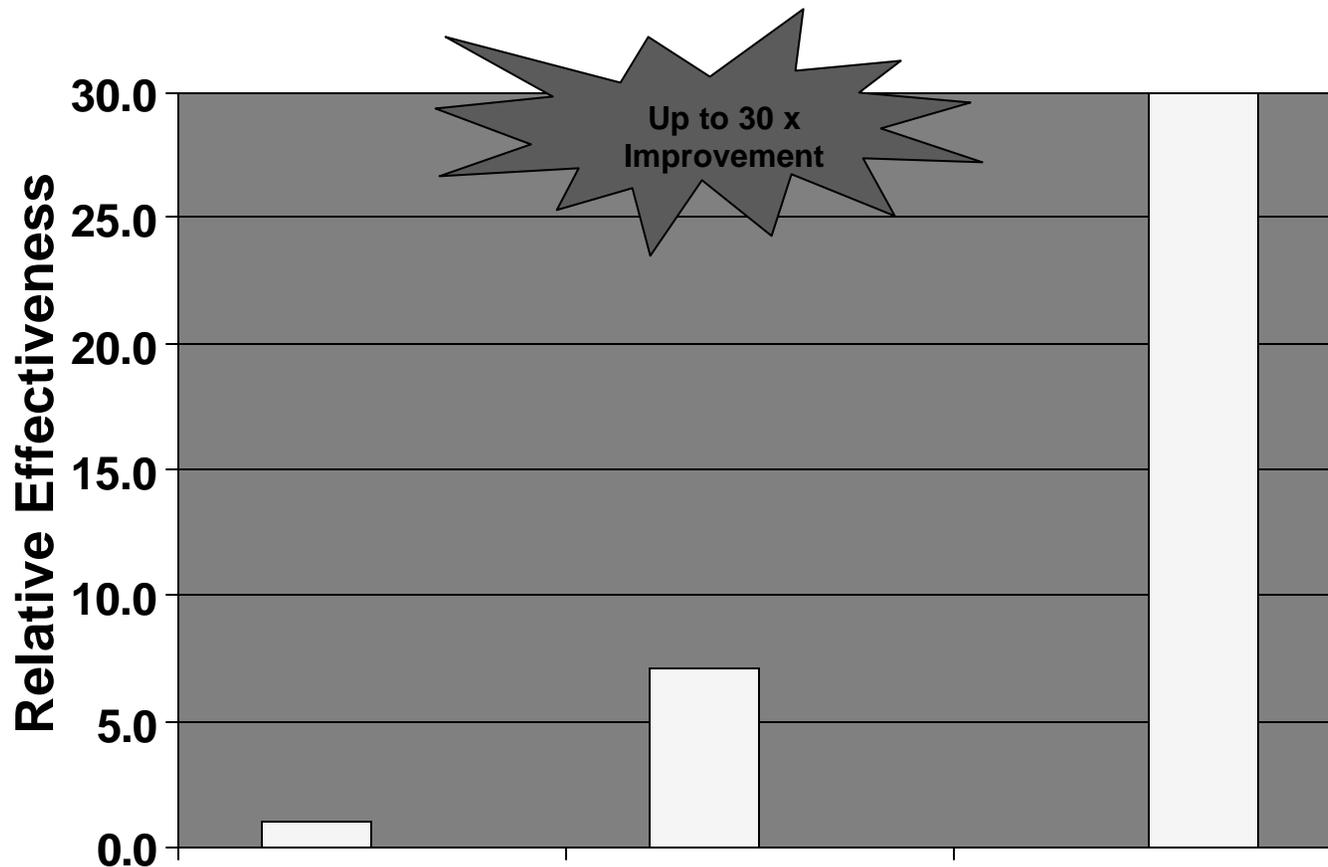


Baseline is M864 @ 30KM w 4 Hr MET

Leveraging LCCM Accuracy Improvements



LCCM and Precision Targeting is Revolutionary (DPICM Projectile vs Area Target at 30KM w/Precision TLE)

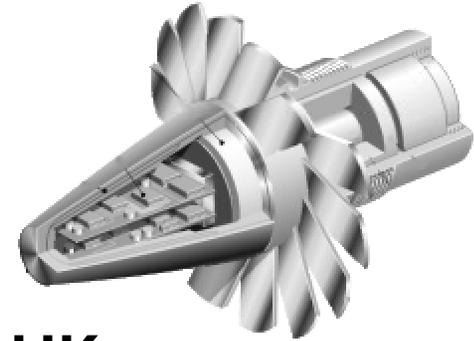


Baseline is M864 @ 30KM w 4 Hr MET

Some Possibilities

- Use Conventional Munitions as Precision Attack Weapons
- Leverage Precision Targeting
- Enhance Smart Munition Performance
- Complicate Countermeasures
- Lighten Firing Platforms

1-D LCCM: Current Status



- **US/UK LCCM GPS Receiver: Feb 99 in UK.**
 - Demonstrated Worlds First Direct P/Y GPS Acquisition in spinning projectile.
 - Navigation Solution in 6 seconds in NATO fuze size (9 cu.in.) package.

- **US/UK GPS Receiver: Aug 99 at YPG in US.**
 - Packaged in NATO standard fuze (9 cu in) assemblies; Fired at 16k G's
 - Successfully demonstrated Direct P/Y- GPS navigation solution in less than 6 seconds using Tactical Projectile Initialization and Oscillator shifts of less than 0.5 ppm.

- **US/UK 1-D Module: Aug 99 at YPG in US.**
 - Drag Brake Deployment using algorithms running on GPS receiver at 16k G's

2-D LCCM: Current Status

- **ARMY/NAVY CM-ATD: Aug 99/Feb 00 at YPG**
 - The LCCM 2-D assemblies were in 13 cu in fuze well packages.
 - Included GPS, Inertial Measure Unit (IMU), Canards Actuator System (CAS), Mission Computer (MC) and a Power Control Generator (PCG).
 - Full System Closed Loop Test (5" Projectile, 7k G's)
 - Full GPS Solution in 6 Seconds
 - Projectile Maneuver Accomplished



LCCM RELATED NAVIGATION TECHNOLOGY AND SYSTEM EFFORTS

- DARPA - ACCELERATION AND SHOCK RESISTANT MEMS FOR MULTI-RATE MEASUREMENT → HIGH-G SERVIVABLE SINGLE PLANE X, Y AND Z MEMS RATE SENSORS
- DARPA - HIGH-G ACCELEROMETERS WITH SOI MEMS FABRICATION → HIGH-G SURVIVABLE ACCELEROMETERS WITH ON-CHIP ELECTRONICS
- DARPA - HIGH-G IMU ON A CHIP → HIGH-G SURVIVABLE 0.3 CU INCH IMU
- JOINT ARMY/NAVY COMMOM GUIDANCE PROGRAM → PHASE 1: COMMOM GUIDANCE MODULE FOR ERGM AND EXCALIBUR
PHASE 2: GUIDANCE INTEGRATED FUZE (2D LCCM)
- L3 GUIDANCE GRAM → ULTRA-TIGHTLY COUPLED GRAM/SAASM GPS RECEIVER
- TRAJECTORY CORRECTABLE MUNITION (TCM) → JOINT US/SWEDISH PROGRAM FOR 155mm GPS/IMU EXTENDED RANGE MUNITION
- NAVY GUIDANCE ELECTRONICS UNIT (GEU) BAA → ALTERNATE GEU FOR CURRENT AND FUTURE GUN LAUNCHED PROJECTILES
- MINIATURE GPS RECEIVERS (L3) TIME EFFORT → 0.5 TO < 0.25 CU INCH HIGH-G, LOW POWER GPS/SAASM RECEIVER
- GPS ANTI-JAM SBIR → DIGITALLY ENHANCED GPS ANTI-JAM TECHNOLOGY
- ERGM → NAVY EXTENDED RANGE GPS GUIDED PROJECTILE
- EXCALIBER → ARMY EXTENDED RANGE GPS GUIDED PROJECTILE

In Summary

- **LCCM Can Significantly Enhance Artillery Effectiveness**
- **LCCM, When Leveraged, Can Provide Revolutionary Improvement**
- **LCCM Impact Goes Beyond the Projectile**
 - **Enables Lighter Platforms**
 - **Enhances Smart Munition Capability**
 - **Complicates Threat Survivability Tactics**